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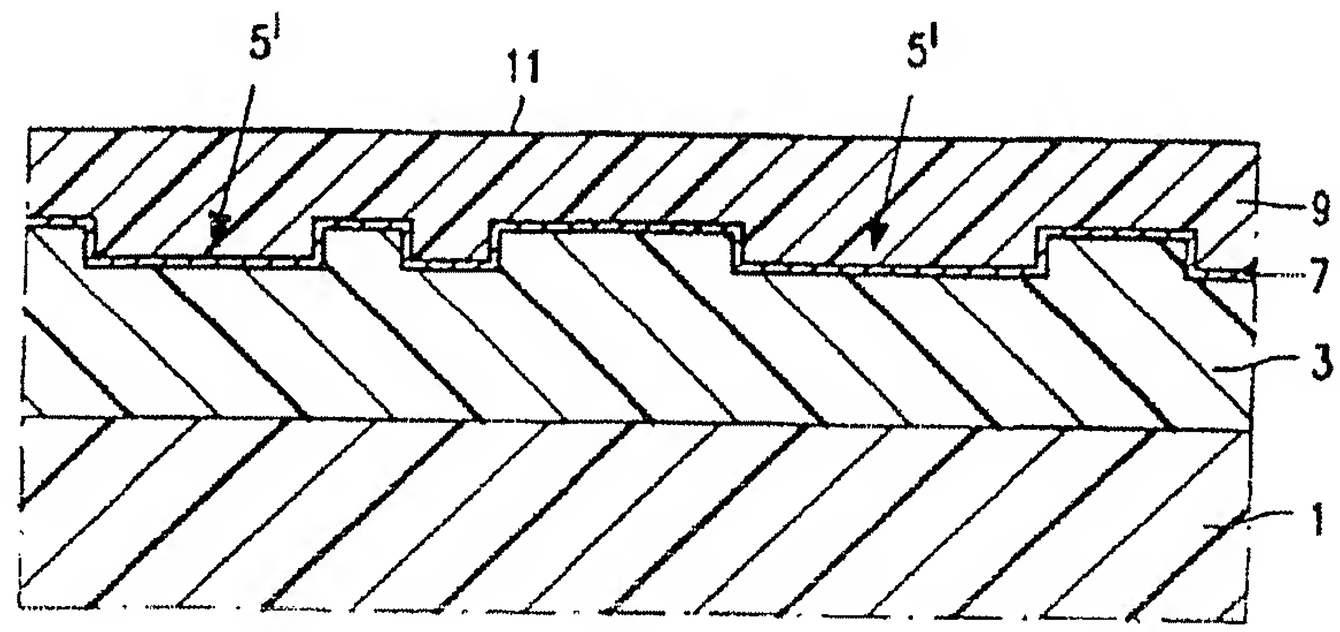

(57) Abstract

A method of manufacturing a read-only optical registration medium in the form of a flexible tape, comprising the following steps: (a) providing a flexible substrate (1) in the form of a tape; (b) providing an embossable registration layer (3) on the substrate (1); (c) embossing the registration layer (3) under pressure with the aid of stamper, so as to form a pattern of high and low surfacial regions (5) representing a collection of binary data; (d) providing a protective film (9) over the embossed registration layer (3). This procedure can be used to produce a novel read-only optical registration medium in the form of a flexible tape with a layered structure which successively comprises: a substrate (1); a registration layer (3); a reflective registration surface (7), in which binary data are represented by localised level-variations (5'), and a transparent, optically-smooth protective film (9), in which there is no metallic reflection layer between the substrate (1) and the registration layer (3), and in which the side (1a) of the substrate (1) remote from the registration layer (3) is rougher than the exposed surface (11) of the protective film (9).

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"Optical registration tape"

The invention relates to a method of manufacturing a read-only optical registration medium in the form of a flexible tape.

The invention also relates to a read-only optical registration medium in the form of a flexible tape having a layered structure.

The invention further relates to a cassette comprising a housing which contains such an optical registration tape in combination with two spools, the tape being partially wound around one of the spools and being connected to the other spool.

In an optical registration medium, recorded binary data can be read by scanning a focused light beam along a reflective registration surface of the medium. Each data bit in this registration surface is represented by a localised region having specific reflection characteristics, which are mutually different for data bits representing a "1" and those representing a "0". For example, in a Compact Disc, data bits are represented by a series of pits in an otherwise smooth registration surface. The depth of these pits is chosen to have a value $\lambda/4n$, whereby the scanning light beam is assumed to be polarised and to have a monochromatic wavelength λ (in air), and the registration surface is assumed to be overlaid by a protective film of refractive index n. As a result, light reflected from a pit-bottom will demonstrate a path-difference of $\lambda/2n$ (phase-difference of π) with respect to light reflected from an un-pitted portion of the registration surface. This phase-shift can in turn be detected on the basis of interference effects. In this manner, it is possible to optically "read" the topography of the registration surface, and thus also the binary bit-streams to which that topography corresponds.

A method as stated in the opening paragraph is known from German Patent Application DE 35 20 111, in which a screen printing procedure is used to create small pigmented domains on a reflective registration surface of a tape. The reflection coefficient of these domains differs significantly from that of the surrounding un-pigmented surface, so that stored data on the tape can be optically read by monitoring the intensity of the scanning light beam after its reflection from the registration surface.

In another method of manufacturing an optical registration tape, use can be made of a so-called phase-change material, which, when locally heated, is capable of undergoing an irreversible change in crystallographic state (*e.g.* amorphous to crystalline), with an attendant change in reflection coefficient. A layer of such material on a tape-like substrate can be inscribed using a focused laser beam whose intensity is modulated in accordance with a given binary bit-stream. In analogy to the medium described above, information can be retrieved from the phase-change layer by monitoring the intensity of a light beam reflected therefrom.

A further method as specified in the opening paragraph is discussed in an article by D. Pountain in *Byte*, February 1989, pp 274-280. This method makes use of laser ablation to blast localised pits in a dye polymer layer which overlies a metallic film on a tape-like substrate. When a focused light beam is directed onto the pitted dye polymer layer, a fraction of the light intensity will be reflected immediately from the surface of the layer, whereas the remaining light intensity will penetrate towards the underlying metallic film, where it too will undergo reflection. The reflected beams from the metallic film and the pitted surface subsequently interfere with one another, to a degree which depends on whether the surfacial beam emerged from a pit or from an unpitted portion of the dye polymer layer. In this manner, the topography of the pitted surface can be optically read.

All of these known methods, and their associated product media, have certain disadvantages. For example:

- In the first medium, the smallest pigmented domains which can be produced using a screen printing procedure have a typical diameter of the order of 20-50 μm. In contrast, the width of the pits on a Compact Disc is of the order of 1μm. It is therefore evident that the storage density of such pigmented tape falls very short of the levels achievable with disc media. In addition, the very nature of the reading procedure regularly exposes the pigmented domains to intense laser light, with the attendant long-term risk of pigment fading and associated increase in noise levels;
- In the case of the second medium, an inherent disadvantage of phase-change materials is that they must be inscribed in real time, *i.e.* the speed at which they are inscribed is of the same order of magnitude as their play-back speed. This is due to the fact that the localised phase-changed domains must be written on a one-by-one basis, using a focused laser beam. An additional disadvantage is the inherent statistical risk of a spontaneous reverse phase-change in some domains

Though this risk is relatively small, it can nevertheless lead to increased noise levels in the long run;

- A drawback of the third medium is that the pits produced by laser ablation are rather ill-defined, with an irregular depth and raised rim walls. In addition, the material removed to create the pits in the first place can precipitate as unwanted debris somewhere else on the medium. Moreover, as in the previous case, the ablative medium must be inscribed in real time, which is tedious (and costly).

It is an object of the invention to provide an alternative method of manufacturing a read-only optical registration medium in the form of a flexible tape. In particular, it is an object of the invention that such a method should circumvent the problems cited hereabove. Specifically, it is an object of the invention to provide a method with which it is possible to create well-defined data domains in a registration layer, without problematic precipitation of debris. Moreover, it is an object of the invention that, if so desired, such domains should have a width of the order of only 1μm. In addition, it is an object of the invention that the new method should allow fast inscription of the said registration layer.

These and other objects are achieved in a method which is characterised in that it comprises the following steps:

(a) Providing a flexible substrate in the form of a tape;

(b) Providing an embossable registration layer on the substrate;

(c) Embossing the registration layer under pressure with the aid of stamper, so as to form a pattern of low and high surfacial regions representing a collection of binary data;

(d) Providing a protective film over the embossed registration layer.

The inventive method exploits a surprising discovery, as will now be elucidated.

Because a registration tape is inevitably wound around itself during storage, and generally makes contact with various wheels and capstans during the reading procedure in a typical play-back device, it is important that the tape should demonstrate a certain surfacial roughness, so as to prevent it from sticking to itself or to other surfaces. On the other hand, an optical registration tape is preferably optically smooth on the side from which its registration surface is read. These two requirements are generally reconciled by ensuring that the side of the tape remote from the registration surface is sufficiently rough. In analogy to magnetic tapes, such a requirement can be economically achieved by depositing

the registration layer on a substrate material containing so-called fillers, *i.e.* embedded microscopic particles. An example of a widely-used substrate material for this purpose is polyethene terephthalate (PET).

One might regard such rough substrate materials as being incompatible with an embossing procedure, in view of the risk of pressing the substantial substrate roughness through to the registration surface during embossing. However, the inventors have discovered such apprehension to be unfounded, and have shown that, surprisingly, well-defined micron-sized pits can be successfully embossed in a registration layer overlying a rough substrate (*e.g.* a photocurable resin layer deposited directly on a PET substrate foil containing fillers). The use of a so-called subbing layer (buffer layer) between the substrate and the registration layer is not essential.

The manifold advantages of the invention are clear. For example, since data inscription involves embossing with a stamper instead of laser ablation, there are no problems with precipitated debris on the registration surface, and the embossed forms (usually pits of constant width but variable length) can be as small and sharply defined as in the case of a Compact Disc. Moreover, embossing with a stamper allows inscription to occur at high speed.

According to the inventive method, the stamper itself may, for example, take the form of a (hard) drum whose cylindrical surface contains microscopic bumps arranged along a helical path, the width of this path being equal to the width of the tape. If such a stamper is rolled along the tape's registration layer, in such a manner that the region of contact between the drum and the tape translates along the said helical path, then the registration layer will be inscribed with pits corresponding to the said bumps.

In an alternative scenario according to the invention, the stamper takes the form of a (hard) tape having a master side which is provided with a longitudinal array of microscopic bumps. If such a stamper tape is wound from one spool to another, and its master surface is thereby rolled at some point against the registration layer of the optical tape, which is concurrently being wound between two different spools at the same speed and in the same direction, then the registration layer will be endowed with pits corresponding to the bumps on the master surface.

The flexible substrate employed in the inventive method may be roughened by the presence of fillers therein (*e.g.* microscopic silica or alumina particles), or by the application of a backing layer thereupon. An example of a suitable substrate material in the first category is LUMIRROR (Toray Industries, Inc.), which is a transparent PET foil

having a thickness of approximately 8 μm and containing fillers with a diameter of the order of 400 nm. On the other hand, a suitable substrate material in the second category is a PET foil which has been coated on one side with a binder (*e.g.* a resin) containing dispersed particles of carbon black, chromium trioxide or calcium carbonate (ideally having a diameter in the range 50-300 nm); the thickness of such a rough backing layer need only be of the order of 1 μm.

In a particular embodiment of the method according to the invention, the embossable registration layer is chosen to comprise a photocurable organic polymeric material, and, during the embossing step (c), the interface of the registration layer with the stamper is exposed to curing actinic radiation. An example of a suitable material in this category is SURPHEX (Du Pont), which is a dry UV-curable material available in the form of thin sheets of standard thickness (in the micron range). Such sheets can be laminated directly to a substrate foil, *e.g.* by heating and rolling. As a further example, use can be made of a dry photocurable resin (*e.g.* an acrylic ester) which can be applied to a substrate foil by dissolving it in a volatile solvent and then roller-coating, spraying or brushing the resulting solution onto the foil.

An alternative embodiment of the inventive method is characterised in that the embossable registration layer is chosen to comprise a thermoplastic which, in the embossing step (c), is first thermally softened, and is then allowed to cool and harden after being impressed upon by the stamper. The employed thermoplastic should have a lower softening temperature than the substrate material; in this manner, the registration layer can be softened without untoward softening of the substrate (with the attendant risk of decreasing the substrate's roughness). Examples of suitable thermoplastics for this purpose are polyvinyl chloride and polypropene.

In yet another embodiment of the inventive method, the registration layer is chemically softened prior to embossing, by applying a chemical solvent to its exposed surface. Candidate solvents for this purpose include, for example, acetone and isopropanol, as well as various chloroalkane solutions, ethers and esters, the exact choice depending on the particular material employed in the registration layer. After it has been embossed, the softened registration layer is hardened by removing the employed solvent therefrom. This can be achieved, for example, by heating the registration layer.

The registration layer will generally have a thickness of the order of 1-10 μm, though a thicker or thinner registration layer is also compatible with the inventive method.

The protective film provided in step (d) of the inventive method may be either inorganic or organic. Suitable inorganic materials such as SiO_2, TiO_2, AlN, Si_3N_4, *etc.*, can be provided by reactive sputter deposition or evaporation, for example. On the other hand, suitable organic materials such as polyurethane or polyacrylate resins can be provided using roller coating, or a spraying or brushing procedure, for example. The protective film will typically be of the order of 2-10 μm thick in the case of an organic film, and 20-500 nm thick in the case of an inorganic film, but may also be thicker, if so desired.

The exposed surface of the protective film is preferably optically smooth. As here employed, the term "optically smooth" is intended to indicate an RMS surfacial roughness which is at most 50 nm, preferably not in excess of 20 nm, and ideally no more than 5 nm. Such a finish is generally achieved automatically, as a result of surface-tension effects in the protective film during its formation.

A particular embodiment of the method according to the invention is characterised in that, between steps (c) and (d), a metallic reflection layer is deposited on the embossed surface of the registration layer. Such a reflection layer may comprise a pure metal or an alloy, and may be provided using sputter deposition, vapour deposition or laser ablation deposition, for example. Exemplary materials for this purpose include aluminium, gold, copper, silver, and their alloys. Use of such a reflection layer ensures that, when the registration side of the medium is scanned with a focused light beam, enough light intensity is reflected to yield an acceptable output signal level.

An alternative embodiment of the inventive method is characterised in that at least one dye is added to the registration layer and/or the protective film, so as to achieve a substantial difference between the refractive indices of the registration layer and the protective film (at the wavelength of the reading light beam). In this manner, it is possible to increase the reflection coefficient at the interface between the protective film and the registration layer (for light incident through the protective film). In particular, for a sufficient difference in refractive index, Total Internal Reflection can be induced at this interface, with a relatively small associated Brewster angle in the protective film. The term "refractive index" as here employed should be interpreted as referring to the complex refractive index $\tilde{n} = n + ik$, where n is the real refractive index and k is the absorption coefficient. The difference between the values of $\tilde{n}$ for the registration layer and the protective film may lie in either the real or imaginary part of $\tilde{n}$, or both. In the case of a dye added to the protective film, however, the value of k for that dye should preferably be relatively small, so as to avoid untoward absorption of the incoming and reflected light beam.

Examples of suitable dyes as discussed in the previous paragraph include pyrylium-4,4'-cyanine and butyl-benzo-indo-carbocyanine. These dyes have respective n-values of 3.270 and 3.050, and respective k-values of 0.570 and 0.058 (all values at a wavelength of 780 nm). Alternatively, use can be made of, for example, a squarylium dye.

If required or if so desired, various other layers may be applied between those provided in steps (a), (b), (c) and (d) of the inventive method. For example:

- An adhesive layer or adhesion-promoting layer may de disposed between the substrate and the registration layer;
- A dielectric layer may be applied between the registration layer and the protective film;
- A rough backing layer may be applied to the side of the substrate remote from the registration layer.

This list is given by way of example only, and is not exhaustive.

The method according to the invention can be employed to manufacture a novel read-only optical registration tape with excellent properties. Such a tape is characterised in that it has a layered structure which successively comprises:

- A substrate;
- A registration layer;
- A reflective registration surface, in which binary data are represented by localised level-variations, and
- A transparent, optically-smooth protective film,

that there is no metallic reflection layer between the substrate and the registration layer, and that the side of the substrate remote from the registration layer is rougher than the exposed surface of the protective film.

The "reflective registration surface" referred to hereabove may be interpreted as being one of the following:

- A metallic reflection layer, applied to the side of the inscribed registration layer remote from the substrate;
- The interface of the inscribed registration layer and the protective film, if use has been made of a dye to enhance the reflection coefficient at this interface.

The "localised level variations" may, for example, be achieved by endowing the registration layer with a pattern of pits or bumps. For example, along any given path, a "1" may be represented by a pit, whereas a "0" may be represented by a level (*i.e.* unpitted) portion of the surface S in which the pits are made, the length of such a pit or level portion being an

integral multiple of some basic unit representing a single bit. Both the surface S and the bottom of each pit are reflective, and reading of the registration surface can be achieved on the basis of the phase-difference between a (polarised) light beam reflected from the surface S and one reflected from the bottom of a pit. For this reason, the magnitude of the level differences in the registration surface is preferably $\lambda/4n$, for (polarised) light of wavelength λ and a protective film of real refractive index n.

Various other layers may also be incorporated in the layered structure of the inventive medium (as already discussed above). These include, for example, adhesive layers, adhesion-promoting layers, dielectric layers, backing layers, *etc*.

The invention also relates to a cassette comprising a housing which contains two spools and the inventive read-only optical registration tape, the tape being partially wound around (at least) one of the spools and being connected to the other spool. In a particular embodiment of such a cassette, the tape passes from one spool to another *via* guiding means which serve to position the tape behind an aperture in the housing in such a manner as to allow *in situ* optical access through the aperture to the registration surface of the tape. However, such guiding means are not strictly necessary: if so desired, the tape can be looped out of the cassette housing and can be read *ex situ*.

The invention and its attendant advantages will be further elucidated with the aid of exemplary embodiments and the accompanying schematic drawings, not all of uniform scale, whereby:

Figure 1 renders a cross-sectional view of a flexible substrate in the form of a tape, on which an embossable registration layer has been provided;

Figure 2 shows the subject of Figure 1 subsequent to the performance of an embossing step thereupon, resulting in the formation of a pattern of low and high surfacial regions in the registration layer;

Figure 3 depicts the subject of Figure 2 subsequent to the provision of a metallic reflection layer on the embossed registration layer;

Figure 4 shows the subject of Figure 3 subsequent to the provision of a protective film over the metallic reflection layer, thereby creating an optical registration tape in accordance with the invention;

Figure 5 depicts manufacturing apparatus for enacting a particular embodiment of the inventive method;

Figure 6 shows a cassette in accordance with the invention.

Embodiment 1

Figures 1-4 depict various stages of a particular embodiment of the method according to the invention, and also of a particular embodiment of the inventive optical registration tape. Corresponding features in the various Figures are denoted by the same reference symbols.

Figure 1 renders a cross-sectional view of part of a flexible substrate 1 in the form of a tape. The substrate 1 has two major surfaces 1a, 1b, and is approximately 8 μm thick. It contains embedded microscopic fillers (not depicted), whose presence causes the surfaces 1a, 1b to demonstrate an RMS roughness of the order of 10-20 nm. An example of a suitable such substrate 1 is a transparent PET foil in which silica particles having a diameter of the order of 400 nm have been dispersed. Such a substrate 1 is commercially marketed under the brand name LUMIRROR (type N997) by Toray Industries, Inc.

An embossable registration layer 3 has been provided on the surface 1b of the substrate 1. This layer 3 has a thickness of the order of 10 μm, and comprises, for example, a dry photocurable resin. In this particular embodiment, the employed resin is SURPHEX P-6 (marketed by Du Pont), which is available in sheet form at a thickness of 6 μm, and was directly laminated onto the substrate 1 at a temperature of 120 °C and a rolling pressure of 250 kPa. The layer 3 presents a surface S remote from the substrate 1.

In Figure 2, the layer 3 has been embossed under pressure with the aid of a stamper (not depicted), in accordance with the inventive method. In this particular embodiment, this has entailed the creation of shallow pits 5 in the surface S. The pits 5 have a depth of approximately 150 nm, a width (perpendicular to the plane of the drawing) of approximately 0.5 μm, and variable length. A suitable embossing procedure is described in Embodiment 2 herebelow.

In Figure 3, the embossed surface of the layer 3 has been coated with a thin metallic reflection layer 7. In this case, the layer 7 is comprised of Al, has a thickness of 100 nm, and has been deposited using Vacuum Vapour Deposition. Because it hugs the contours of the original embossed surface of the registration layer 3, the layer reflection 7 demonstrates a series of sharply defined pits 5' in an otherwise smooth exposed surface.

Figure 4 shows the subject of Figure 3 after the provision thereupon of a

protective film 9. The material of the film 9 is, in this case, a polyacrylate resin, and has been roll-coated onto the reflection layer 7 to a thickness of approximately 5 μm. The exposed surface 11 of the film 9 is optically smooth, with an RMS roughness of 5 nm. This finish is naturally achieved as a result of surface tension effects in the film 9 during its formation on the underlying reflection layer 7.

Embodiment 2

Figure 5 depicts manufacturing apparatus for enacting a particular embodiment of the inventive method. The employed stamper 51 has the form of a cylindrical aluminium drum with a diameter of 150 mm and a length of 165 mm, and with a relief pattern of microscopic bumps on its cylindrical surface 51a. The manner in which such bumps can be created is discussed in Embodiment 3 herebelow.

Also depicted in the Figure is a roller 53 of similar diameter to the drum 51 but having a hard paper layer of thickness 5 mm on its cylindrical surface 53a. The drum 51 and roller 53 are arranged with their cylindrical axes parallel to one another, and with their cylindrical surfaces 51a, 53a pressed against opposite sides of an interposed optical registration tape 55, which is as yet unembossed. This tape 55 extends substantially perpendicular to the said cylindrical axes, in such a manner that its (curable) registration layer is in contact with the relief pattern on the surface 51a.

The drum 51 is pressed against the roller 53 with a force of 5000 N, resulting is a pressure of the order of 15 N/mm^2 on the tape 55. By rolling the drum 51 and roller 53 against one another, the interposed tape 55 is pulled through between them, and its registration layer is embossed along its length with a series of pits corresponding to the bumps on surface 51a.

The registration layer on the tape 55a is cured by directing actinic radiation R (*e.g.* UV radiation) onto that region 55a of the tape 55 which, at any given time, is still in contact with the surface 51a. If so desired, supplementary curing can be subsequently performed using a second beam of actinic radiation R'.

Once curing has been performed, the tape 55 passes through an on-line deposition chamber 57, where the embossed surface of the tape 55 is provided with a vacuum-evaporated metallic reflection layer. In an alternative scenario, the tape 55 is first wound onto a buffer spool A, which can later be transferred into a vacuum chamber; the tape

55 is then unwound from the spool A and metallised on its embossed side.

The tape 55 is subsequently provided with a protective film on its embossed side. This is here achieved by roller-coating the tape 55 in a roller-coater 59. If required, the freshly coated tape 55 may be subsequently dried using a heat source or air flow H. Alternatively, if the applied resinous liquid is photocurable, then the means H can be regarded as comprising actinic radiation for the purposes of curing the freshly applied film.

In a further process step, the tape 55 is either wound onto a buffer spool B, or is directly wound into a cassette housing 511. If required, the tape 55 may first be cut to an appropriate (uniform) lateral width (*e.g.* 8 mm) with the aid of cutting wheels 513.

Embodiment 3

The microscopic bumps on the cylindrical surface 51a of the stamper drum 51 can be created using either a direct or indirect procedure, as will now be explained.

In a suitable direct procedure, the cylindrical surface 51a is coated with a layer of photoresist. Using an appropriate interposed mask, this layer of photoresist is irradiated in accordance with the desired surfacial pattern of bumps, and is subsequently developed and cross-linked.

In an appropriate indirect procedure, the process described in the preceding paragraph is performed on one side of a sheet or ribbon, which is then wound around the drum 51 in such a manner that the bumped side of the sheet or ribbon faces outward and forms the surface 51a.

Embodiment 4

Figure 6 depicts a particular embodiment of a cassette 60 in accordance with the invention, comprising a housing 62 which contains two spools 64 and a read-only optical registration tape 66 according to the invention. Also depicted is an aperture 68 in a wall of the housing 62. The tape 66 can be wound back and forth from one spool 64 to the other, and is thus arranged that its registration surface faces the aperture 68. In this manner, the reflective registration surface of the tape 66 can be accessed *in situ* by a light beam entering and leaving the housing 62 through the aperture 68. In order to facilitate accurate

focusing of such a light beam on the tape 66, the housing 62 may also contain guide means (not depicted), which serve to maintain a given length of the tape 66 at a constant distance from the aperture 68. Such guide means may, for example, comprise a reference block over which the tape is spanned and which is located behind the aperture 68.

In an alternative embodiment of the inventive cassette 60, the guide means referred to hereabove may be omitted from the housing 62, and the tape 66 may be read using a play-back device which loops a given length of the tape 66 out through the aperture 68 and then reads it *ex situ*, in analogy to a VHS video cassette, for example. For such purposes, the aperture 68 is preferably much wider than here depicted, so as to facilitate mechanical access to the tape 66.

In both of these embodiments, the aperture 68 is preferably located behind a mechanical shutter door (not depicted), so as to protect the tape 66 from dust and scratches.

CLAIMS

1. A method of manufacturing a read-only optical registration medium in the form of a flexible tape, characterised in that it comprises the following steps:

(a) Providing a flexible substrate in the form of a tape;

(b) Providing an embossable registration layer on the substrate;

(c) Embossing the registration layer under pressure with the aid of stamper, so as to form a pattern of low and high surfacial regions representing a collection of binary data;

(d) Providing a protective film over the embossed registration layer.

2. A method according to Claim 1, characterised in that the substrate is chosen to comprise an organic polymeric film throughout which microscopic particles have been dispersed.

3. A method according to Claim 1 or 2, characterised in that one side of the substrate is roughened by the application of a backing layer thereupon.

4. A method according to any of the Claims 1-3, characterised in that the embossable registration layer is chosen to comprise a photocurable organic polymeric material, and that, in the embossing step (c), the interface of the registration layer with the stamper is exposed to curing actinic radiation.

5. A method according to any of the Claims 1-3, characterised in that the embossable registration layer is chosen to comprise a thermoplastic which, in the embossing step (c), is first thermally softened, and is then allowed to cool and harden after being impressed upon by the stamper.

6. A method according to any of the Claims 1-5, characterised in that, between steps (c) and (d), a metallic reflection layer is deposited on the embossed surface of the registration layer.

7. A method according to any of the Claims 1-5, characterised in that at least one dye is added to the registration layer and/or the protective film, so as to achieve a substantial difference between the refractive indices of the registration layer and the protective film.

8. A read-only optical registration medium in the form of a flexible tape

having a layered structure, characterised in that the layered structure successively comprises:

- A substrate;
- A registration layer;
- A reflective registration surface, in which binary data are represented by localised level-variations, and
- A transparent, optically-smooth protective film,

that there is no metallic reflection layer between the substrate and the registration layer, and that the side of the substrate remote from the registration layer is rougher than the exposed surface of the protective film.

9. A cassette comprising a housing which contains two spools and a read-only optical registration medium in the form of a flexible tape, the tape being partially wound around one of the spools and being connected to the other spool, characterised in that the tape has a composition in accordance with Claim 8.

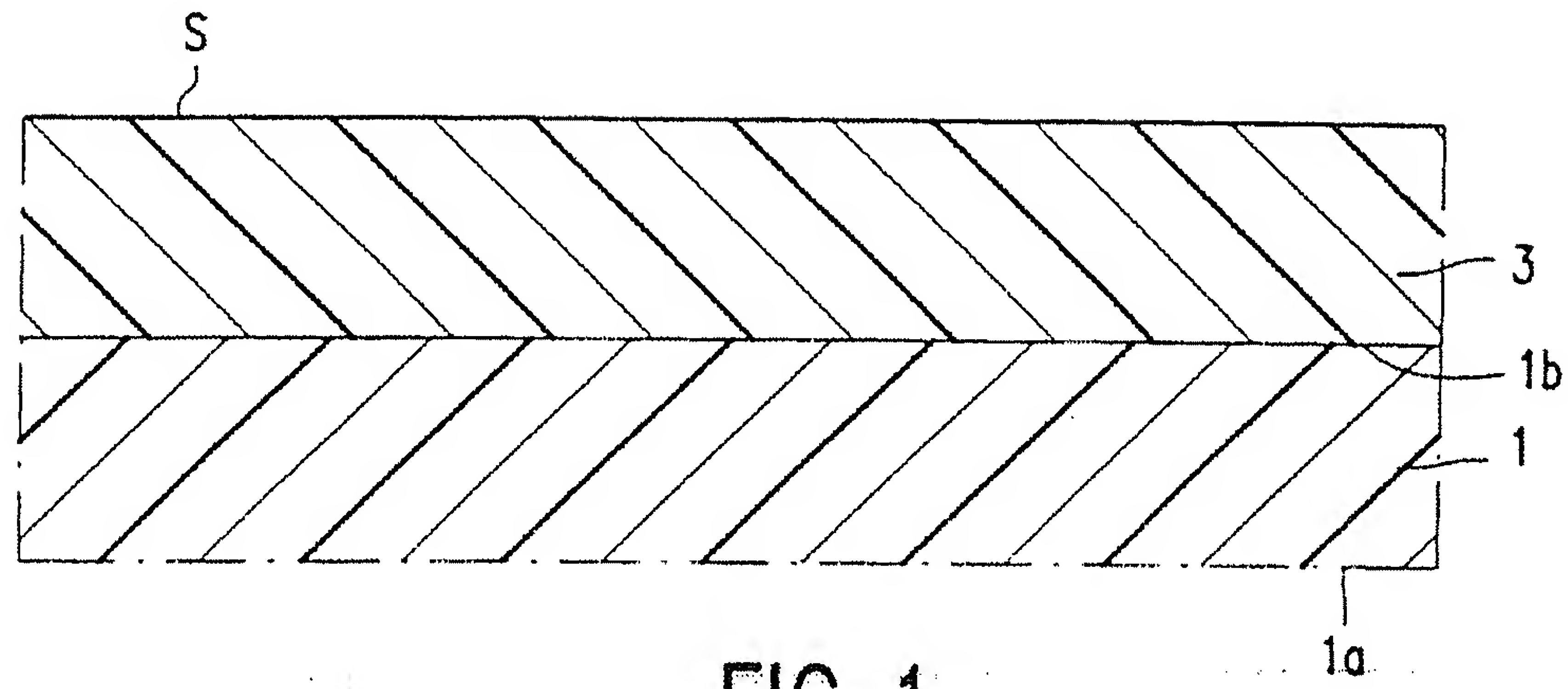

FIG. 1

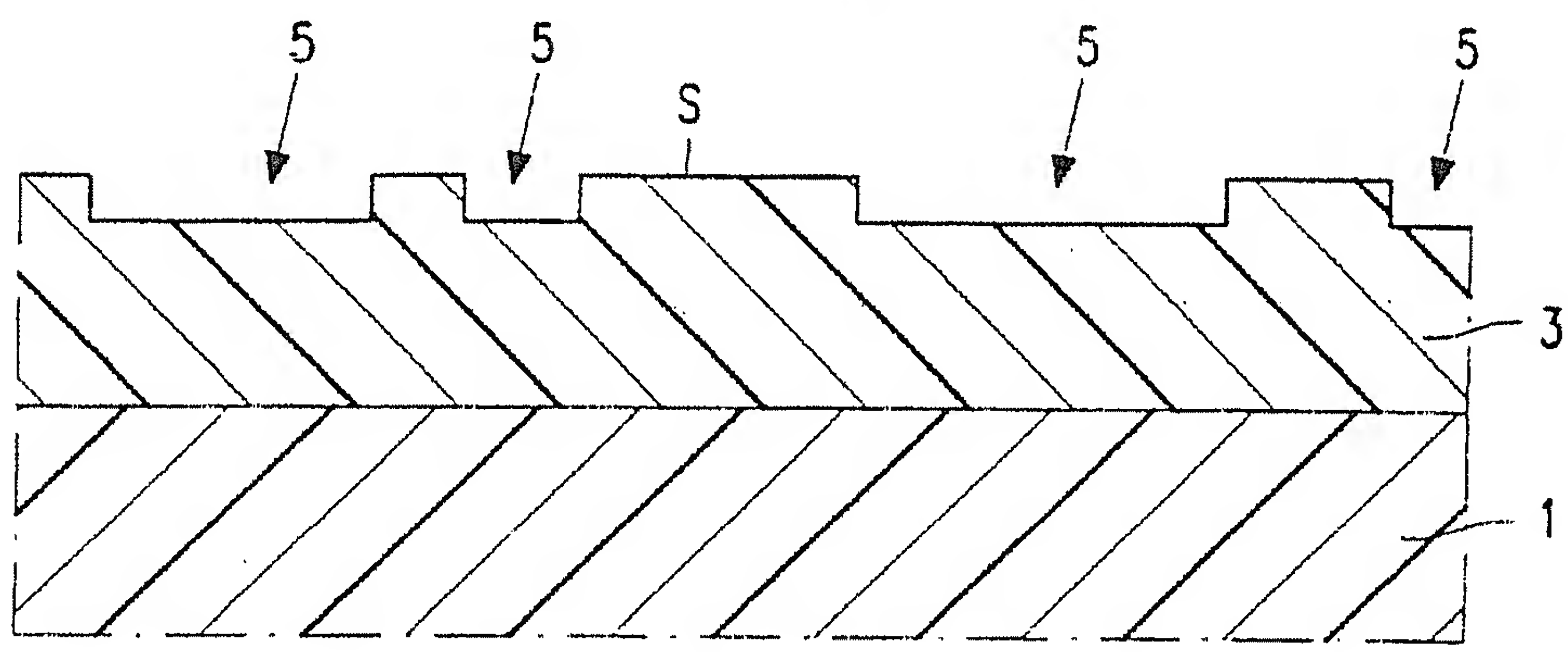

FIG. 2

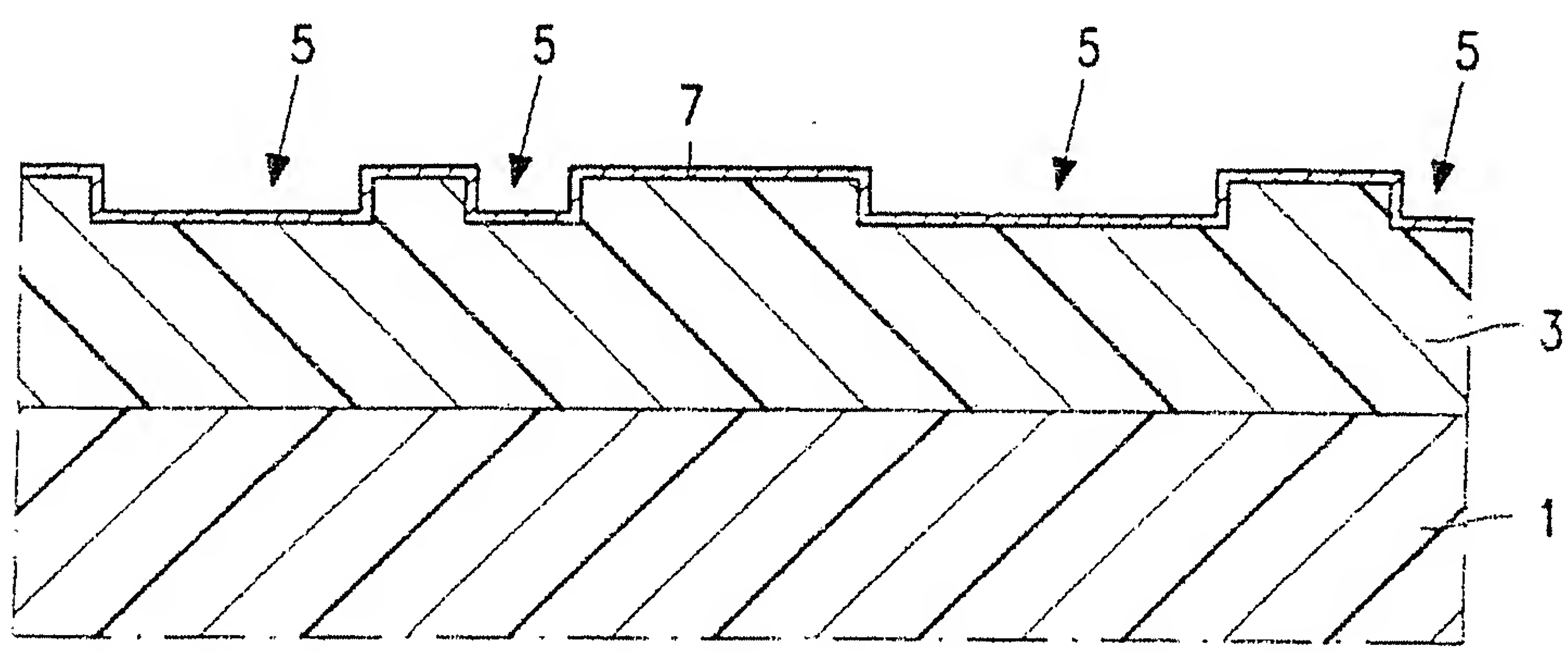

FIG. 3

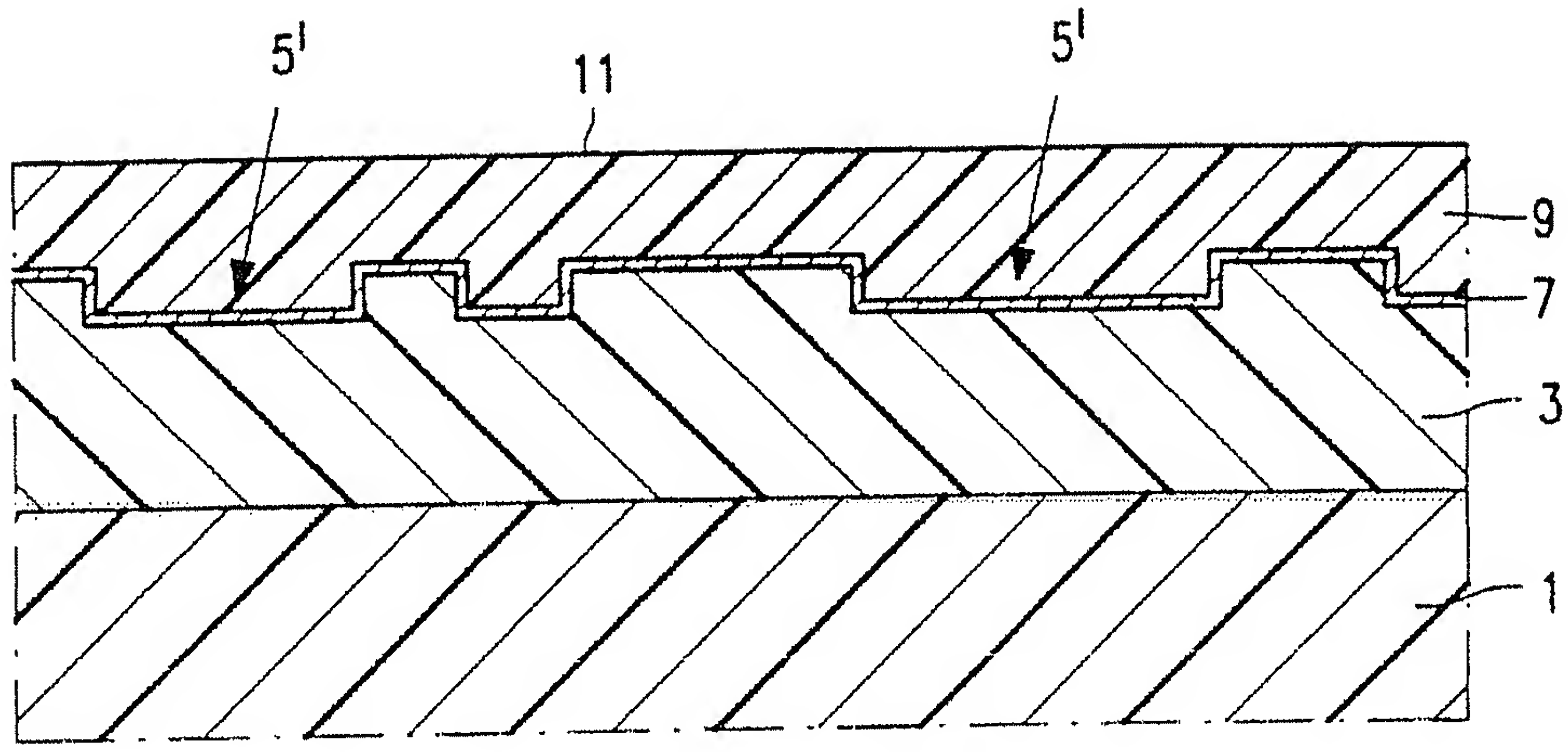

FIG. 4

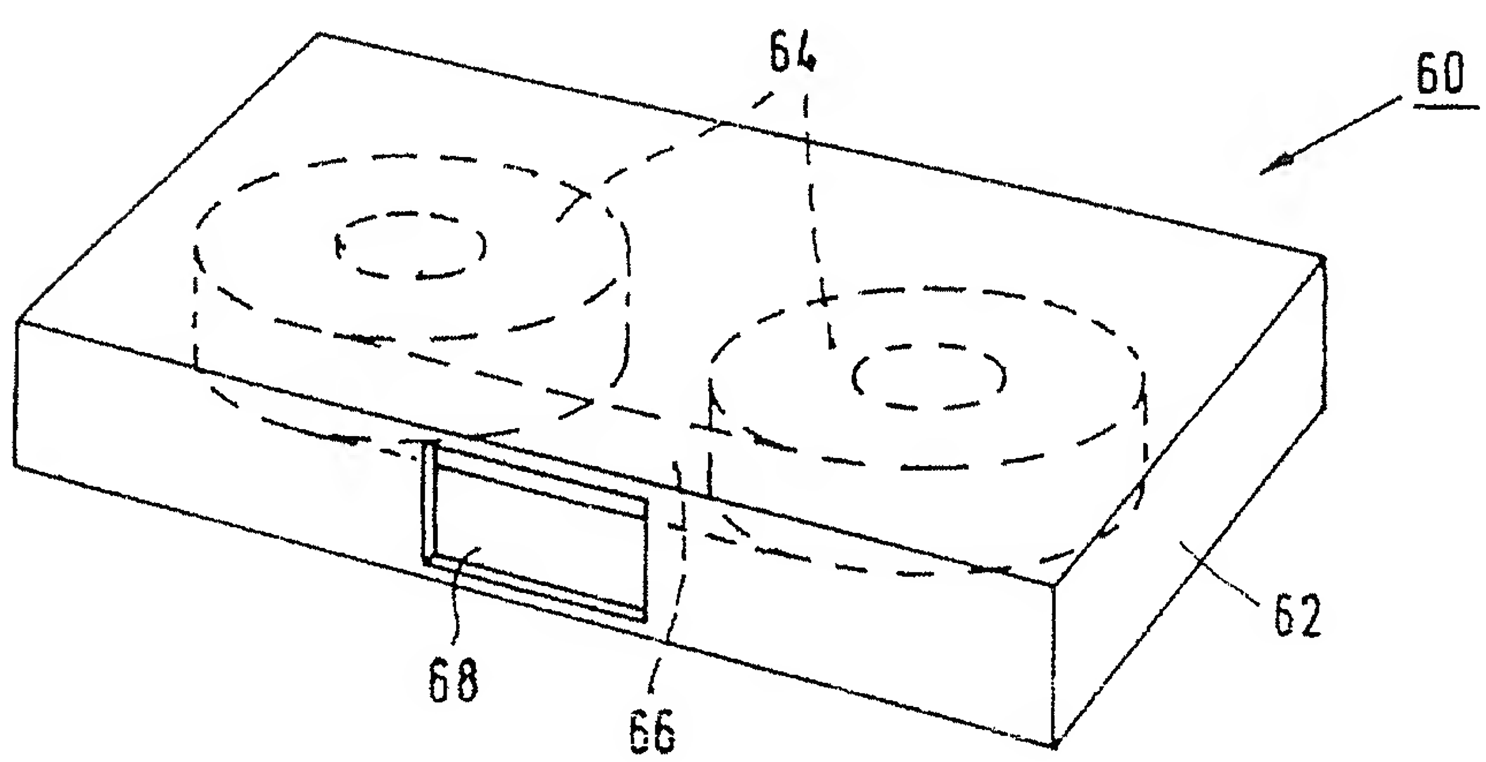

FIG. 6

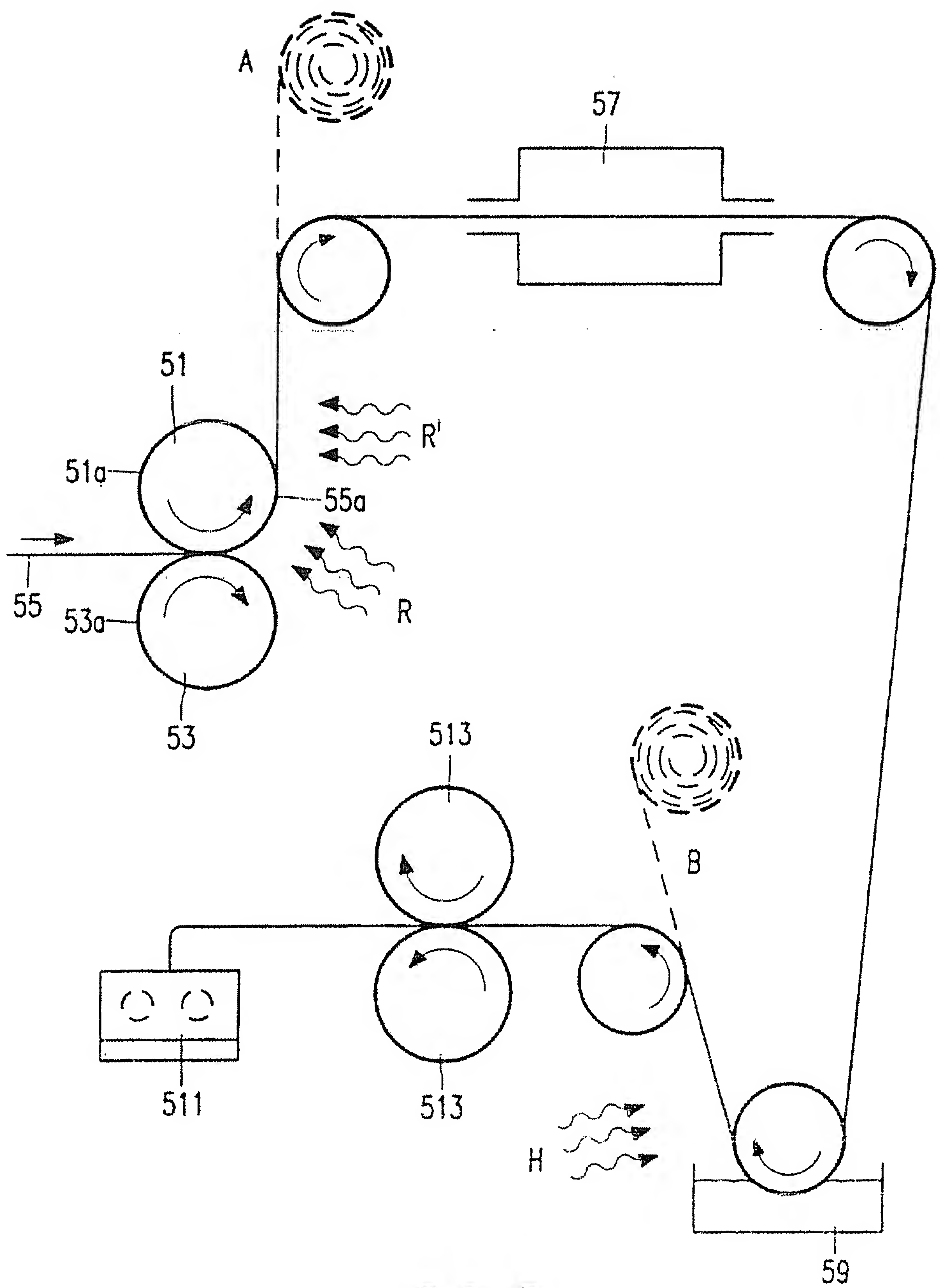

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB 96/00995

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: G11B 7/00, G11B 7/24, G06K 1/12, G06K 19/06
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: G11B, G06K, C09K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPAT, JAPIO, WPIL, IFIPAT

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 45676 A5 (KIME), 3 Sept 1991 (03.09.91), column 4, line 59 - line 68; column 5, line 9 - column 6, line 27; column 9, line 16 - column 10, line 20, figure 10	1-2,6-9
A		3-5
	--	
X	US 4937810 A (DREXLER ET AL), 26 June 1990 (26.06.90), column 1, line 33 - line 51; column 4, line 54 - column 5, line 2; column 5, line 55 - column 6, line 11, figures 3,4	1-3,8-9
A		4-7
	--	

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 February 1997	04-03-1997
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Benny Andersson Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB 96/00995

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5141785 A (YOSHINADA ET AL), 25 August 1992 (25.08.92), column 58, line 61 - column 59, line 19, column 59, line 61-63, column 60, line 21-25 and column 61, line 15-24	3,7
X		1,2,4-6,8,9
	--	

INTERNATIONAL SEARCH REPORT
Information on patent family members

03/02/97	International application No. PCT/IB 96/00995

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A5- 45676	03/09/91	NONE	
US-A- 4937810	26/06/90	CA-A- 1286610	23/07/91
		GB-A,B- 2189926	04/11/87
		JP-A- 62256249	07/11/87
		US-A- 4762770	09/08/88
		US-A- 4788129	29/11/88
		US-A- 4884260	28/11/89
		US-A- 4910725	20/03/90
		US-A- 4957580	18/09/90
		US-A- 4999278	12/03/91
US-A- 5141785	25/08/92	DE-D,T- 69025788	17/10/96
		EP-A,B- 0392531	17/10/90
		JP-A- 2273338	07/11/90